Instruction Manual

JOHN FLUKE MFG. CO., INC.

ELECTRONICS FOR INDUSTRY

INSTRUMENTS / COMPONENTS

Preliminary Instruction Manual

for

FLUKE MODEL 415A

HIGH VOLTAGE POWER SUPPLY

Serial No. 123 and above

JOHN FLUKE MFG. CO., INC.

P. O. Box 7428, Seattle, Washington 98133

Preliminary Instruction Manual
for
FLUKE MODEL 415A
HIGH VOLTAGE POWER SUPPLY

August 1, 1967

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SECTION I
INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. GENERAL DESCRIPTION

1-3. The Model 415A High Voltage Power Supply is a stable well regulated source of dc voltage. Output voltage from the instrument is adjustable from 0 to 3100 volts dc. Front panel step type switch controls provide a means of voltage adjustment in one volt incremental steps. A vernier control provides a means of fine adjustment within the one volt steps. The power supply may be used to power photomultiplier tubes, high voltage klystons or other devices with current requirements up to 30 milliamperes. Output power is available from both a front and rear high voltage type UG 931/U connector. Output voltage polarity switching is provided to enable the instrument to be operated with either a positive or a negative voltage output with respect to the chassis ground of the instrument.

1-4. The high voltage power supply combines the best features of electron tubes with solid state components in a hybrid circuit. The improved reliability and temperature stability characteristics of silicon transistor amplifiers and rectifier diodes together with the high voltage handling characteristics of vacuum tubes provide a dependable, low noise level, highly regulated voltage output from the instrument.

1-5. The power supply is provided with protective circuitry to prevent damage to the instrument in the event of an overload or short circuit in the output. Normal operation is quickly restored following the removal of the overload by a manual reset control.

1-6. The instrument is wired at the factory for operation at 115 volts ac. Conversion for operation at 230 volt ac input is made by a change in the connections of the primary winding of the input power transformer. Information to make the conversion is provided on the schematic diagram following section V of the manual, together with decal information on the transformer.

1-7. ELECTRICAL SPECIFICATIONS

OUTPUT VOLTAGE
Adjustable from 0 to ±3100 volts dc.

OUTPUT CURRENT
0 to 30 milliamperes.

OUTPUT POLARITY
Positive or negative with respect to chassis ground. (The polarity is controlled by means of a front panel switch.)

OUTPUT VOLTAGE LOAD REGULATION
0.001% or 5 millivolts (whichever is greater) for a full load change.

OUTPUT VOLTAGE RIPPLE
Less than 100 microvolts RMS.

RESOLUTION
5 millivolts.

LINE REGULATION
0.001% or 2 millivolts (whichever is greater) for a 10% line change from nominal.

STABILITY
±0.005% per hour, ±0.02% per day (after warmup).

CALIBRATION ACCURACY
±0.25% or 100 millivolts (whichever is greater) with vernier control at zero.

OVERCURRENT PROTECTION
Adjusted to disconnect output at 32 milliamperes load current. Manual reset.

INPUT POWER
115/230 volts ac ±10%, 50 to 60 Hz, approximately 300 volt-amperes at full load output. (Operation at 400 Hz upon request).

1-8. MECHANICAL AND ENVIROMENTAL SPECIFICATIONS

OUTPUT CONNECTORS
UG931/U connector front and rear.

OUTPUT MONITOR
Meter, center position. 0 to ±3100 volts dc (±3%).

SIZE
19" wide x 3-1/2" high x 15" depth.

WEIGHT
Approximately 30 pounds.

HUMIDITY
0 to 80%.

OPERATING TEMPERATURE
0° C to 50° C.

STORAGE TEMPERATURE
-20° C to 70° C.

ALTITUDE OF OPERATION
Sea level to 10,000 feet.

STORAGE OR SHIPPING ALTITUDE
Sea level to 50,000 feet.

VIBRATION
In accordance with MIL SPEC. MIL-T-945A.

SHOCK
In accordance with MIL SPEC. MIL-E-4970A.

TEMPERATURE COEFFICIENT OF OUTPUT
Less than 20 ppm per degree C from 10° to 40° C.

SECTION II

OPERATING INSTRUCTIONS

2-1. CONTROLS, TERMINALS, AND INDICATORS

2-2. The location and functional description of external controls, terminals, and indicators on the Model 415A are given in Figure 2-1.

2-3. INPUT POWER

2-4. The 415A may be used on 115/230 vac ±10% at a frequency of 50 to 60 cycles. The transformer in the 415A Power Supply has dual primary windings, which are usually connected in parallel for 115 volt operation. When requested, the primary windings are connected in series for 230 volt operation. If it becomes desirable to change from one operating voltage to the other, remove the top cover of the instrument and change the jumper wires and the fuse as shown on the transformer decal.

2-5. INITIAL OPERATION

2-6. The following procedure is recommended when operating the Model 415A for the first time after shipping or a long period of idleness. This procedure will minimize the possibility of damage resulting from a faulty component.

a. Connect the line plug to a 115 vac power source. If the instrument has been wired for 230 volt operation, connect to 230 vac.

WARNING!

This instrument is equipped with a 3-wire line cord, one lead of which is connected to the metal chassis. Connection to a properly-wired outlet automatically connects the chassis of the instrument to earth ground. If an adapter is used to connect the line to a two-contact outlet, the green lead extending from the adapter should be connected to a suitable ground.

b. Set the HIGH VOLTAGE switch to STBY/RESET.

c. Set the POWER switch to ON. The ON lamp will illuminate. After approximately 30 seconds, the time-delay relay will close and the STBY/RESET lamp will illuminate.

d. Set the second OUTPUT VOLTAGE dial to 500.

CONTROL, TERMINAL, or INDICATOR	LOCATION	FUNCTIONAL DESCRIPTION
POWER switch	Front panel	Applies AC line power to the control circuit and to the primary of the transformer.
POWER ON indicator lamp	Front panel	Illuminates when power is applied to the control circuit and transformer.
HIGH VOLTAGE switch	Front panel	Used to apply transformer power to the high-voltage rectifiers when the STBY/RESET lamp is illuminated.
STBY/RESET indicator lamp	Front panel	Indicates completion of the time-delay cycle, by illuminating 30 seconds after line power is applied to the 415A. The HIGH-VOLTAGE switch must be set to STBY/RESET for completion of the time-delay cycle.
HIGH VOLTAGE ON indicator lamp	Front panel	Illuminates when the high voltage is available at the OUTPUT connectors.
POLARITY switch	Front panel	Selects an output either positive or negative with respect to chassis ground.
OUTPUT VOLTAGE dials	Front panel	The first four dials select the output voltage in five steps of 500 volts, five steps of 100 volts, nine steps of 10 volts, and nine steps of 1 volt, respectively. R23 provides a continuous output range of 0 to 1.2 volts.
Voltmeter	Front panel	Indicates the approximate output voltage from -3.1 to +3.1 kv. Accuracy is ±3% of full scale.
Output connectors	Front and back panels	UG931/U connectors provided for connecting the load to the instrument. One mating connector is supplied.

Figure 2-1. FUNCTION OF EXTERNAL CONTROLS, TERMINALS, AND INDICATORS

e. After the STBY/RESET lamp illuminates, set the HIGH VOLTAGE switch to ON. Carefully observe if the HIGH VOLTAGE ON lamp illuminates and if the panel meter indicates 500 (±63) volts.

CAUTION:

If the output exceeds 563 volts, immediately set the HIGH VOLTAGE switch to STBY/RESET.

f. If the output voltage is within tolerance, the power supply may be operated as in paragraph 2-7 or 2-8. If the output is not within tolerance, perform steps g. through i.

g. Set the HIGH VOLTAGE switch to STBY/RESET.

h. Locate and correct the source of trouble.

i. Repeat the initial operating procedure, steps b. through e.

2-7. OPERATING PROCEDURE

a. Set the POWER switch to ON. The ON lamp will illuminate.

b. Set the HIGH VOLTAGE switch to STBY/RESET. After approximately 30 seconds the time-delay relay will close and the STBY/RESET lamp will illuminate.

c. Set the POLARITY switch to the desired polarity.

d. Set the OUTPUT VOLTAGE dials to the desired output.

CAUTION:

Rapidly decreasing the setting of the OUTPUT VOLTAGE dials with the high voltage on may damage the sampling string resistors. When dialing down the output voltage, pause approximately 1/2 second in each switch position.

e. Connect the load circuit securely to the output connector. Check the external circuit for conflicts in grounding before applying power to the load.

WARNING:

This power supply can produce lethal voltage. Always set the HIGH VOLTAGE switch to STBY/RESET and wait until the output voltage has decayed to zero before connecting or disconnecting the load.

f. After the STBY/RESET lamp illuminates, set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish and the HIGH VOLTAGE ON lamp will illuminate. The panel meter will indicate the approximate output voltage.

NOTE:

If the overcurrent trip level has been reduced from the factory setting of 32 ma, it may be necessary to set the HIGH VOLTAGE switch to ON with a reduced output voltage setting, to prevent actuating the overcurrent trip when the HIGH VOLTAGE switch is set to ON. In this case, step d, above, would follow step f. If the HIGH VOLTAGE switch is set to ON immediately after the STBY/RESET lamp illuminates, any overload will cause the output voltage to oscillate between ON and STBY/RESET. The oscillation can be stopped and/or prevented by correcting the overload condition.

g. To remove the high voltage from the output connector, set the HIGH VOLTAGE switch to STBY/RESET.

NOTE:

When the HIGH VOLTAGE switch is in the STBY/RESET position, there may be a voltage of 2 to 3 volts present at the output connector, due to grid conduction of the passing tubes.

h. The output polarity of the 415A may be changed at any time when no load is connected to the instrument. When a load is connected, especially one that is highly reactive, the HIGH VOLTAGE switch should be set to STBY/RESET, or the output voltage should be reduced to 500 volts, before changing the output polarity. If the polarity is switched at high output voltages with reactive loads, the POLARITY switch may be damaged.

i. The 415A is protected from overload damage by an overcurrent protection circuit which removes power from the high voltage rectifiers at an output current of 32 ma, or at the value set during calibration of the instrument. When the overload trip is acuated, the HIGH VOLTAGE ON lamp will extinguish. The high voltage may be re-applied to the output connectors as follows:

(1) Set the HIGH VOLTAGE switch to STBY/RESET. After approximately 30 seconds the STBY/RESET lamp will illuminate.

(2) Set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish and the HIGH VOLTAGE ON lamp will illuminate. The output voltage will be available at the output connectors.

2-8. CALIBRATION OF METERS

2-9. The 415A may be used for direct calibration of dc instruments to an accuracy of 0.25% or 100 mv at 3100 cardinal points, 1 volt apart, from 0 to 3099 volts. The vernier dial provides an additional 1.2 volts of range for calibration between cardinal points. Proceed as follows:

a. Set the POWER switch to ON. The ON lamp will illuminate.

b. Set the HIGH VOLTAGE switch to STBY/RESET. This allows the time-delay relay to start its cycle. After approximately 30 seconds, the time-delay relay will close and the STBY/RESET lamp will illuminate.

c. Set the POLARITY switch to the desired polarity.

d. Connect the instrument being calibrated firmly to the power supply. Check the external circuit for conflicts in grounding before applying power to the load.

e. After the STBY/RESET lamp illuminates, set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish and the HIGH VOLTAGE ON lamp will illuminate.

f. Set the first four OUTPUT VOLTAGE dials to the desired cardinal point. Use the last dial if a calibration point between the one volt cardinal points is desired.

g. To remove the output voltage from the output connector, set the HIGH VOLTAGE switch to STBY/RESET.

2-10. When used with a John Fluke differential voltmeter and voltage divider, the 415A is capable of calibrating dc instruments from 0 to 3100 volts with an accuracy of 0.01% to 0.06% with 5 millivolts resolution. For calibration of instruments from 0 to 500 volts, proceed as follows:

a. Set the POWER switch to ON. The ON lamp will illuminate.

b. Set the HIGH VOLTAGE switch to STBY/RESET. After approximately 30 seconds, the time-delay relay will close and the STBY/RESET lamp will illuminate.

c. Set the POLARITY switch to the desired polarity.

d. Connect the instrument being calibrated securely to the power supply. Check the external circuit for conflicts in grounding before applying power to the load.

e. Connect a John Fluke differential voltmeter to the instrument being calibrated.

f. Set the differential voltmeter to measure the voltage desired at the calibration point.

g. Set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish and the HIGH VOLTAGE ON lamp will illuminate.

h. Null the differential voltmeter by adjusting the OUTPUT VOLTAGE dials. The accuracy of the voltage measured is from 0.01% to 0.05%, depending on the accuracy of the differential voltmeter used.

i. Set the HIGH VOLTAGE switch to STBY/RESET.

j. Repeat steps f. through i. for as many calibration points as desired.

2-11. For calibration of instruments from 500 volts to 3100 volts, proceed as follows:

a. Set the POWER switch to ON. The ON lamp will illuminate.

b. Set the HIGH VOLTAGE switch to STBY/RESET. After approximately 30 seconds, the time-delay relay will close and the STBY/RESET lamp will illuminate.

c. Set the POLARITY switch to the desired polarity.

d. Connect the instrument being calibrated firmaly to the power supply. Check the external circuit for conflicts in grounding before applying power to the load.

e. Connect a John Fluke Model 80E Voltage Divider to the instrument being calibrated, and connect a differential voltmeter to the 10 volt maximum output divider terminal.

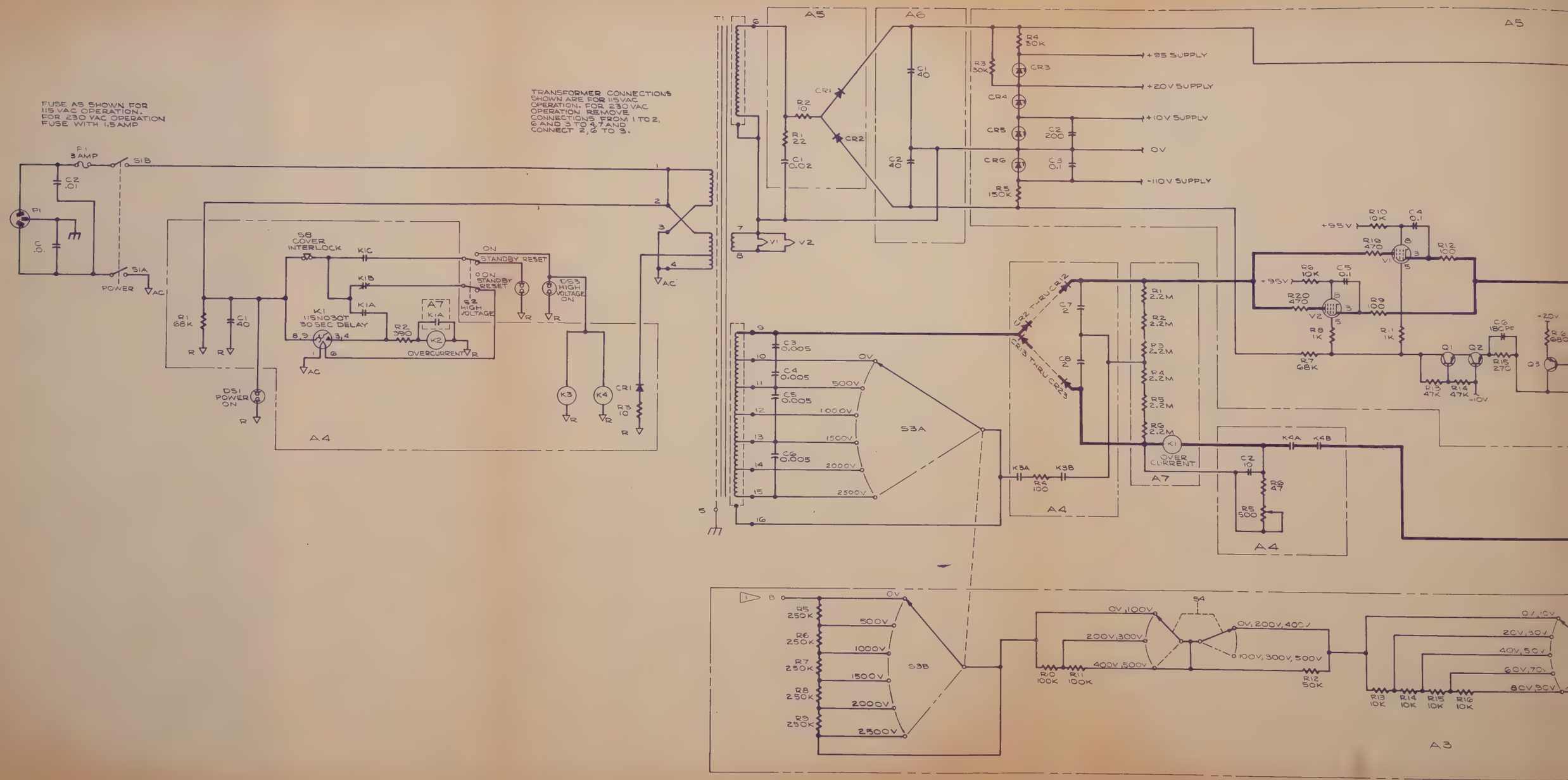
f. Set the differential voltmeter to measure the voltage at the desired calibration point, considering the voltage division ratio of the voltage divider.

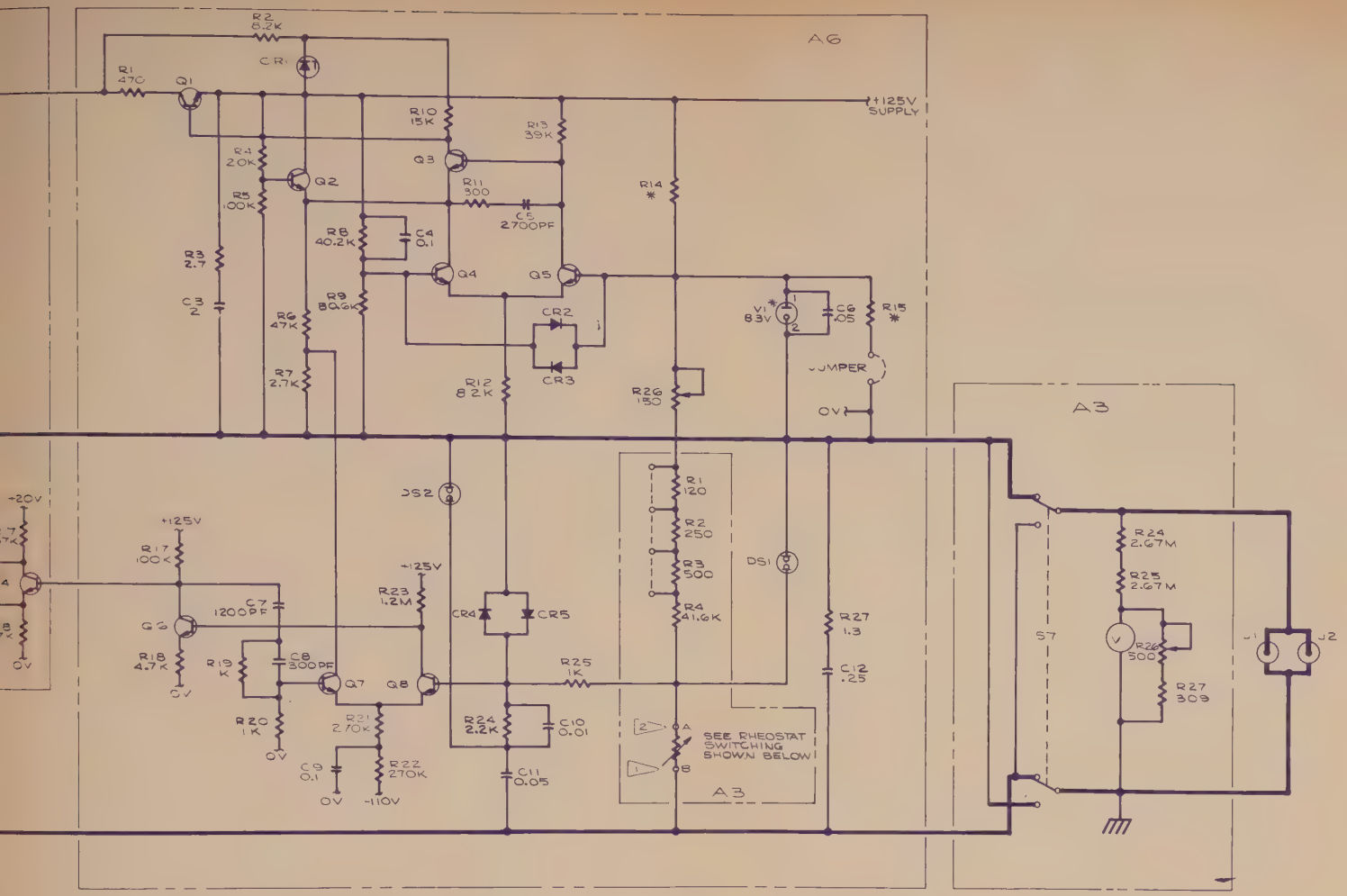
g. Set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish and the HIGH VOLTAGE ON lamp will illuminate.

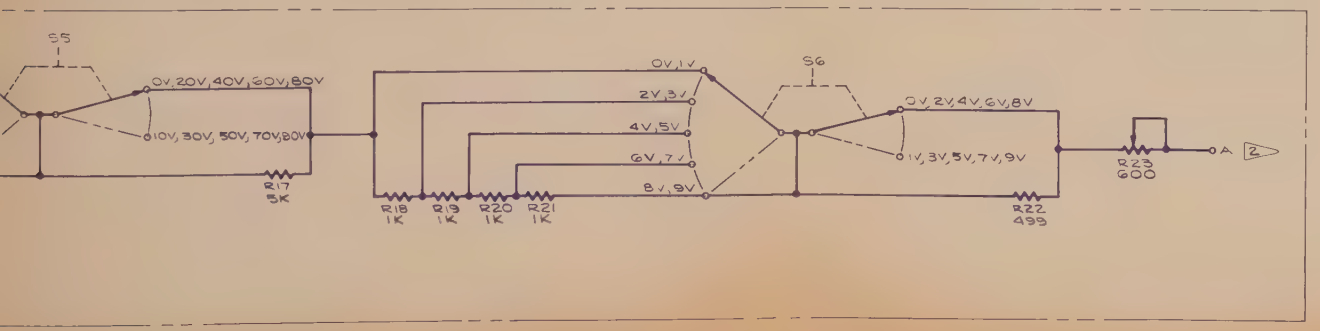
h. Null the differential voltmeter by adjusting the OUTPUT VOLTAGE dials. The accuracy of the voltage measured is from ±0.02% to ±0.06%, according to the accuracy of the differential voltmeter and voltage divider used.

i. Set the HIGH VOLTAGE switch to STBY/RESET.

j. Repeat steps f. through i. for as many calibration points as desired.


FUSE AS SHOWN FOR 115 VAC OPERATION. FOR 230 VAC OPERATION FUSE WITH 1.5 AMP
TRANSFORMER CONNECTIONS SHOWN ARE FOR 115 VAC OPERATION. FOR 230 VAC OPERATION REMOVE CONNECTIONS FROM 1 TO 2, 6 AND 3 TO 4, 7 AND CONNECT 2, 6 TO 3.
F1 3 AMP
S1B
S1A
POWER
P1
C2 .01
C1 .01
AC
S8 COVER INTERLOCK
K1C
K1B
K1A
K1 115VAC 30 SEC DELAY
R1 68K
C1 40
R2 390
K2
OVERCURRENT
A7
S2 HIGH VOLTAGE
ON STANDBY RESET
DS3 HIGH VOLTAGE ON
DS1 POWER ON
K3
K4
CR1
R3 10
A4
T1
A5
A6
CR1
CR2
R2 10
R1 22
C1 0.02
C2 40
V1
V2
C1 40
R4 30K
R3 30K
CR3
CR4
CR5
CR6
C2 200
C3 0.1
R5 150K
+95 SUPPLY
+20V SUPPLY
+10V SUPPLY
0V
-110V SUPPLY
C3 0.005
C4 0.005
C5 0.005
C6 0.005
0V
500V
1000V
1500V
2000V
2500V
S3A
CR2 THRU CR12
CR13 THRU CR23
C7 2
C8 2
R1 2.2M
R2 2.2M
R3 2.2M
R4 2.2M
R5 2.2M
R6 2.2M
K1 OVER CURRENT
K3A
K3B
R4 100
C2 10
R6 47
R5 500
K4A
K4B
R10 10K
C4 0.1
+95V
R16 470
R12 100
R6 10K
C5 0.1
R20 470
R9 100
R8 1K
R11 1K
R7 68K
C6 180 PF
R15 270
Q1
Q2
Q3
R13 47K
R14 47K
-10V
+20V
R6 68
R5 250K
R6 250K
R7 250K
R8 250K
R9 250K
S3B
0V, 100V
200V, 300V
400V, 500V
S4
0V, 200V, 400V
100V, 300V, 500V
R10 100K
R11 100K
R12 50K
0V, 10V
20V, 30V
40V, 50V
60V, 70V
80V, 90V
R13 10K
R14 10K
R15 10K
R16 10K
A3





NOTES:

(6) * FACTORY SELECTED COMPONENT

(5) ⏚AC INDICATES AC RETURN

(4) ⏚R INDICATES DC RETURN

(3) ⏚ INDICATES CHASSIS GROUND

(2) RESISTANCE IN OHMS, CAPACITANCE IN MICROFARADS UNLESS OTHERWISE NOTED

(1) ▷ ALL FLAGNOTES WITH THE SAME NUMBER ARE CONNECTED

FUNCTIONAL SCHEMATIC

HIGH VOLTAGE

DC POWER SUPPLY

MODEL 415A

MODEL 415A SER. NO. 123 & ON

FLUKE JOHN FLUKE MFG. CO., INC.

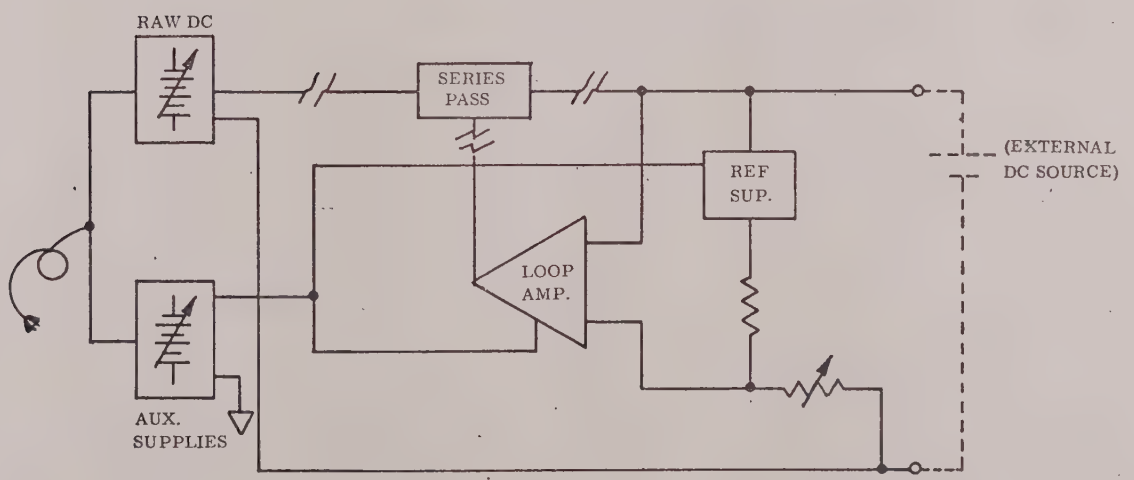
P O Box 7428 Seattle, Washington 98133

CHECKOUT PROCEDURE FOR POWER SUPPLIES

Any high voltage power supply can be split off into its individual block entities so that each block may be examined for proper operation before all of them are combined to constitute an entire instrument.

The proper procedure for checking any power supply should follow the guidelines listed below.

1) Disable the series pass element (s) by removal or circuit disconnection.
2) Check all auxiliary supplies for proper output voltage, stability, and ripple content.
3) Monitor the Reference section of the instrument (Zener, or separate power supply) for the same parameters as indicated in step 2, except that the checking should be much more stringent.
4) Perform a Loop Amplifier check of the instrument to insure that it will regulate properly when provided with an error signal.
5) Check the raw DC section of the unit for appropriate levels of voltage. For those instruments that have Pre-regulators in the raw DC section, it will be necessary to check out the associated control ciruitry.



Only after it can be shown that each block entity is working properly should they all be put together and called an "operable" Power Supply. There is no guarantee at this point whether or not the instrument will meet all of its E_o specifications, but at least it should be able to be turned on to produce an E_o without catastrophic failure.

RELATING POWER SUPPLY ANALYSIS TO APPLICATION SYMPTOMS

1. Developing the symptom.

   a) Is it so catastrophic that the instrument is inoperable? If so, go directly to Loop Analysis.

   b) Is the instrument operable, but on a marginal basis? If so, operate it in as many settings as possible (Range, Dialed Output, etc.) to determine complete symptom description.

   c) Is the instrument generally operable, except for a particular area that is deemed to out of the ordinary? (e.g. a point out of tolerance, slightly high ripple, limiting controls borderline, etc.)

2. Relating symptom to simplified block diagram of any power supply.

   a) Catastrophic failures are usually related to the raw Hi Voltage section of the instrument.

   b) As long as the instrument is operable, the field broadens as to the actual block area of the instrument at fault. However, a simple "rule of thumb" is that:

      If the symptom is one where the front panel controls have little, or no, response ---- the problem most likely will be associated with the Loop Amplifier.

      If the problem is associated with a marginal spec, it may be well to consider the elements around the amplifier, such as the Reference Supply, R_1, or R_o.

3. Isolating the problem area of the instrument.

   a) Disable the supply's ability to allow hi voltage at the output in any form.

      Pull series pass element

      Pull pre-regulator PCB (332 type supply)

   b) Check all auxiliary supplies for proper operating condition; nominal voltage, stability, etc.

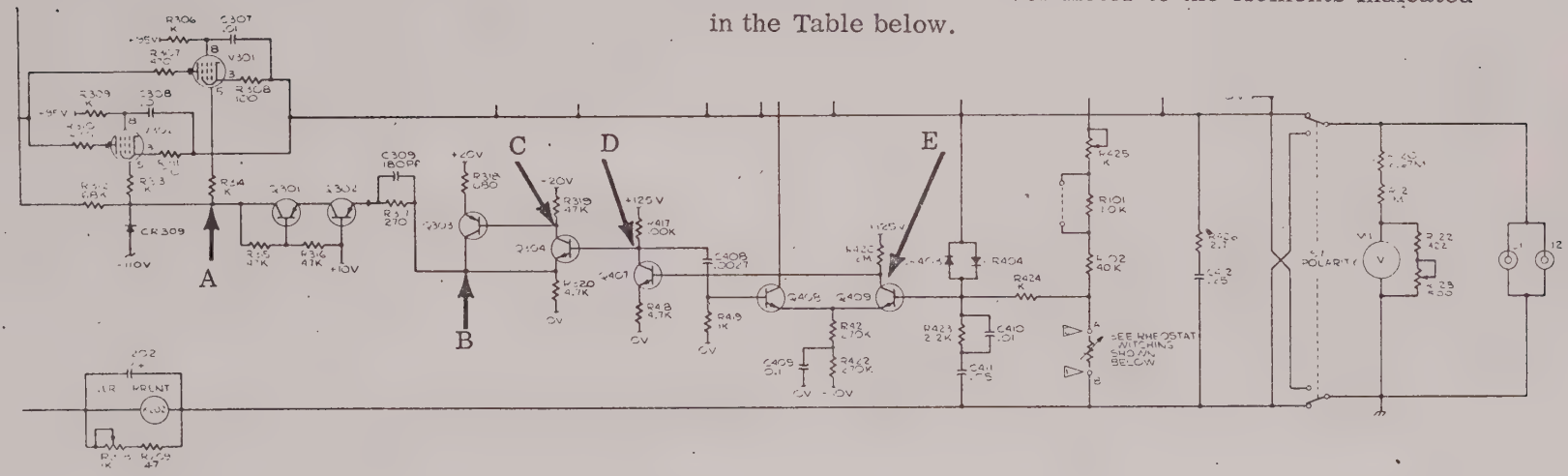
   c) Check raw DC section in and of itself to see if it will be sufficient to supply any desired output. If it has preliminary controls, it is also possible to check these.

   d) Check the Reference Supply as a separate entity to see that it will properly reflect on the output voltage. Note that in the formula for power supply operation, output voltage is directly proportional to the Reference voltage. ($E_o = R_o/R_1 \times E_{Ref}$)

   e) Check the Loop Amplifier for proper operation. The same technique that is applied to the Calibration Power Supplies is also suitable for the Nuclear type supplies.

Conditions of Measurement

Series Pass Tubes Removed.
Unit "ON", Positive Polarity, "STANDBY" mode.
Connect a Mercury battery to Output Connector. Pos. to Pos., and Neg. to Connector Shell(chassis).
Connect a Differential Voltmeter to the elements indicated in the Table below.



With a differential Voltmeter(883, or equiv.) referenced to the + Output, read the following voltages at the indicated points on the schematic.

Dialed Voltage	Point "A"	Point "B"	Point "C"	Point "D"	Point "E"
1V	-100V	+6V	+18.5V	+6.6V	+7.1V
2V	+9.5V	+13V	+13V	+13.6V	-.14V

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON

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Edmundson, Missouri
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NEW JERSEY

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